Analog, digital, and the cybernetic illusion

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Abstract *In the first part of this article cybernetics is reconstructed as a new techno-philosophy subverting ontological borders and thus promising a forthcoming utopia of unified knowledge. In the second part this is exemplified by the discussions about the terms »analog« and »digital« at the Macy-Conferences 1946-1953. There, the new cybernetic epistemology is founded on a suppression of the »real« (i.e. the physical, continuous, material, analog) by the »symbolic« (i. e. the artificial, discrete, logical, digital). In the third part this is embedded in a broader philosophical and historical context. First, the difference between »analog« and »digital« resembles the Kantian difference of »senses« and »reason«. Together they form the »illusionary« function, which a digital-oriented cybernetics tries to abandon. Second, this attempt to get rid of illusion produces a »cybernetic illusion«, that (according to Foucault) replaces the anthropological illusion. Heinz von Foerster's work could be seen as an attempt to keep cybernetics experimental, to establish a balance of power between analog and digital, and to respect the illusionary function of knowledge.*

Cybernetics as utopian science

When I started collecting European books on cybernetics from the 50's and 60's I was impressed: during that time no field of knowledge remains untouched by cybernetics. There are books on cybernetics and theology, anthropology, and medicine; on cybernetics in politics, sociology, and economy, in fine arts, literature, and military strategy; on cybernetics and pedagogics, homeopathics, and anthroposophy; books for scientists and laymen; books for children and adults. It seems that almost everydiscipline became infected by a virus called cybernetics and started a process of reformulation or critique of its own fundamental terms in a cybernetic vocabulary.

From a historical point of view one might say that this was just a reflection or repetition of what happened in the ›primal scene‹ of the *Macy Conferences*, because they transported the notion of »interdisciplinarity« from wartime

conditions to the so-called ›peace‹ of cold war times. In the papers of Warren McCulloch I discovered several lists of names that show how carefully this interdisciplinarity was constructed: 2 guests from electronics, 2 from psychology, 2 from anthropology, and so on. [1] And from another point of view it might be important that those people from different academic backgrounds and institutional contexts needed to find a common language or a set of shared differences to talk to each other. It's not at all surprising that Heinz von Foerster, who was the observer of this self-regulative process of observations inside the grouplater developed theories of second-order-observation. But I think there's more behind the enormous success of cybernetics.

Guillaume Apollinaire once wrote: »What would become of the world if machines started thinking?« Warren McCulloch's and Walter Pitt's famous paper of 1943 on the *Logical Calculus of Ideas* turned this question from its head to its feet: What if our thinking is already done by machine? By abstracting synaptic activity to logical circuits they flattened the metaphysical process of »thinking« to switching and symbol manipulation. But at the same time McCulloch/Pitts introduced a kind of Platonism (as Lily Kay called it in one of her last essays [Kay 2001]) into cybernetics. The principles of logic and Boolean algebra seem to exist somewhere outside our eternal world, but like Plato's immortal ideas they can be ›embodied‹ in the ›instruments of time‹ (Plato). So every thinkable thought can be implemented or embodied by a logical network. That's the reason why the logical calculus is so perfectly supported by Shannon's information theory: information remains the same regardless of it's embodying medium. It doesn't matter if information is stored in vacuum tubes or synapses or as ink on paper as long as the differences remain. The materiality of the medium simply doesn't matter for its functioning.

By this move McCulloch founded a new techno-philosophy and became (in a way) the first deconstructivist. It was a philosophy that was very different from the way philosophers thought about technology before – different from Kapp, Frazer, Freud, and (later) McLuhan thinking of technologies as ›extensions of men‹, and different from Nietzsche who had the typewriter in mind, when he was thinking about the ›hardware‹ of philosophy. McCulloch's Platonism was subverting or deconstructing several hierarchical differences like human and non-human, subject and object, *psyche* and *techne*, man and apparatus. If man is just one of many possible implementations of an information-processing machine, then the notion of man starts to blur – a notion that was absolutely necessary for the rise of human sciences since the 18th century. (Just remember Immanuel Kant's most important question: »What is Man?«) So Michel Foucault's famous sentence of 1966 concerning »the death of Man«, »erased, like a face drawn in sand at the edge of the sea«, was already formulated 20 years before by cybernetics – but not via a radical re-thinking of philosophy (as Foucault [1973] suggested) but via a radical re-thinking of technology. In 1943 ontology became deconstructed and restless. What emerged was at least the hope for a new ›order of things‹, a sphere in which »animal and machine« (to quote Norbert Wiener) are no longer separated – a sphere of »technical being« (to quote Max Bense) that is »wider than what once was called nature or mind« (Bense, 1998).[2]

So I think the utopian impact of cybernetics was its dream of various modes of reconciliation. Just remember that McCulloch tried (in his own words) to write »a theory in terms so general that the creations of God and men almost exemplify it.« Dealing with this dream was an enormous task that might be described by the term »experimental epistemology«. The experiment lies in the re-ordering of knowledge in a way that psychological and sociological, political and economical, aesthetical and biological phenomena can all together be rooted in the same fundamental terms of information and

feedback. This produced a huge (but also fascinating) workload especially for humanities, because for the last two centuries Man (functioning, wishing, or de-signing [*bezeichnend*]) has been the reference and center of knowledge on the phenomena of life, economy or language. This utopian project of reconciliating a separated knowledge in one universal science was the reason for so many diagrams in popular books showing the term »cybernetics« in the center of a circle and all other disciplines grouped around – like a gravitational center that holds several planets in their perfect circles.

I am not daring to speculate on the impact the social and political situation of the 50's had on this conception, but I want to recall Leibniz, who was often quoted as a ›patron‹ of cybernetics. So it seems to be more than a coincidence that Leibniz had the idea of a universal language and method of science built on formalized systems and deduction. Leibniz' four main points are: 1. to find discrete, ›atomic‹ symbols, 2. to set up rules for the order of those signs, 3. to ensure the reference between the symbolic and the real, and 4. to formulate transformation rules for generating new terms out of those symbols. In the last point of this scientific utopia we might discover an early version of Hilbert's concept of meta-mathematics, which was so important for digital computers. But I just want to focus on the points concerning discrete symbols and their reference.

Analog, digital, and the ›productive devil‹

The notions of analog and digital have been discussed at each of the ten *Macy Conferences*, and it seems that this never-ending topic is in some way so painful that it has to be cut off. The most traitorous episode was when Ralph Gerard said the words »synapses are *not* acting digitally« (Pias, 2003, p. 175). This sentence caused another long and fundamental discussion that ended with the following famous dialog: »Gerard: May I speak now? McCulloch: No,

not now.« (Pias, 2003, p. 193) As far as I can see this is the only passage in 750 pages where someone is no longer allowed to speak.

It's not the right place here to resume all of the arguments about analog and digital, but I would like to emphasize at least three aspects of the discussions.

The *first* is represented by a statement of John von Neumann who gave the first talk on analog/digital at the first conference in 1946: »I [Neumann said] consider the living organisms as if there were purely digital automata« (Neumann, 1951, p. 10). Von Neumann represents the engineer's point of view. According to McCulloch's summary of the 1946 conference »[h]e contrasted these digital machines with analogical mechanisms in which numbers were represented continuously by magnitudes of length, force, voltage or whatnot, and he pointed out the superiority of the former to the latter with respect to their ability to extend their precision indefinitely by the addition of like components.« (McCulloch, 1947, p. 2) So the reason for not thinking about analog devices is an economical one, an efficient way of building ›electronic-brains‹ to compute computable numbers and solve solvable problems. This might strengthen recent speculations that John von Neumann's interest in cybernetics was limited or perhaps just a kind of camouflage for his interest in building faster computers for military purposes. (Pias, 2003, vol. 2, pp. 253-270)

The *second* aspect may be represented by a contrapunctual statement of Norbert Wiener saying: »Every digital device is really an analogical device«. (Pias, 2003, vol. 1, p. 158) This refers to various devices discussed as examples of analog and digital modes, like the abacus, the vacuum tube, the amplifier, the coin, etc. Several oppositions were tested in these discussions like continuously coded vs. discretely coded, linear vs. nonlinear, physics vs. artifact, precision vs. repetition, measuring vs. counting etc. The boundaries between analog and digital are (at least for Wiener) floating in two respects:

the *first* is that there is no strict antagonism, because analog objects can gradually be transformed into digital ones. (For example one can put granulations on a slide ruler and thus produce fields of attraction where it digitally ›snaps in‹.) The second is that digital devices are able to control analog ones and analog ones are able to control digital ones. (For example the analog hormonal condition of the body ›modifies‹ or controls the digital synaptic activity, but also a digital computer may control a chemical plant). The conclusion is that our world is analog, but we introduce ›artificial‹ digital elements at specific levels to gain certain advantages. So Wiener insists on a balance of power between analog and digital aspects. This is not only true for the human body that has both digital (= synaptic) and analog (= humoral) parts, but also for forthcoming hybrid computers that should take advantage of »non-digital ways«.

The *third* aspect of the discussion may be represented by John Stroud's statement that »[t]he devils are generally working somewhere in between« (Pias, 2003, vol. 1, p. 182). The final or ›official‹ definition in McCulloch's *Points of Agreement Reached in the Previous Ten Conferences* refers exactly to that problematic »in between«. He writes: »[A]s long as the probability of a state between our permitted states is great and has to be taken into account, we have still a flavor of the continuous. When the probability of the *Zwischen*-state is zero or negligible, we think chiefly in other terms [i.e. digital]. That is, I think, purely a matter of practicality.« (Pias, 2003, vol. 1, p. 197) What is camouflaged by this ›practicality‹ is the fact that a discoursive prohibition [*Diskursverbot*] takes place. Julian Bigelow, a colleague of Wiener, emphasized: »I think it is essential to point out that this involves a forbidden ground in between and an agreement never to assign any value whatsoever to that forbidden ground« (Pias, 2003, vol. 1, p. 187).

My impression is that McCulloch, von Neumann and others tried to expand that forbidden ground of the analog as far as possible, and that they had good

reasons to do so, because this strategy promised to be highly productive. Shannon's information theory and McCulloch's logical calculus are completely dependant on digital notions, and that means that the whole new universal cybernetic epistemology wouldn't work if it's not based on digital terms. Not only for building effective computers, but also for building an effective discourse of experimental epistemology one has to be »ignorant« (as Walter Pitts called it) – ignorant »of the actual continuity« (Pias, 2003, vol. 1, p. 186) in all things that virtually might be digital. »[T]reat them as if these transition states did not exist. It is quite a good way of treating them«, said John Stroud (Pias, 2003, vol. 1, p. 184).

So it seems that the »experimental epistemology« of early cybernetics was built on specific ways of forgetting, neglecting, and ignorance – of forgetting the analog aspects (or ›nature‹) of its objects, of neglecting their materiality, and of ignorance about most of their states. This is quite interesting because all of the protagonists were working highly application-oriented during the war (Wiener on missile control and prostheses, Neumann on computer hardware, McCulloch on frogs, Shannon on secrecy systems etc.). But with the rise of cybernetics after World War II the gap between application (which has to deal with the material resistance of its objects) and speculative theory becomes increasingly large. We may already decipher that drifting-apart on the cover of Norbert Wiener's most popular book. It has two alternative titles of which one is widespread and the other one specific: *Cybernetics or Control and Communication in the Animal and the Machine*. And we may even trace back that difference to Wiener's article of 1943 on *Behavior, Purpose and Teleology*. In its last category of »active, purposeful, teleological behavior« (the category that machines and living organisms both belong to) there is no idea of materiality or implementation. The only relevant thing is a functional similarity in behavior. And if one skips 10 or 20 years forward and looks inside some of the books on cybernetics from the 50's and 60's he will clearly see what was

caused by this neglect of materiality. We find there hundreds of illustrations showing highly different activities (like breathing, flying to the moon, educating children, painting pictures, controlling a factory, cooking a meal and so on) which all have a diagrammatic overlay showing a feedback loop of information and control and thus stating or ›proving‹ that they all could be described or explained by cybernetics regardless how different they are in a material world. Matter doesn't matter.

The cybernetic illusion

I think there is a philosophical term that might reflect the difference of analog and digital. It's the term »illusion« I found in Kant's *Critique of Pure Reason*. There, the chapter on *Transcendental Dialectics* begins with the statement that truth and appearance [*Wahrheit* and *Schein*] are not to be found in the object [*Gegenstand*] but in judgement [*Urteil*] (Kant, 1990, pp. 334-338). The pure intellect [*der reine Verstand*] never makes wrong judgements because it always acts according to its own laws and is necessarily identical with itself. The pure senses [*die reinen Sinne*] don't make right or wrong judgements but no judgements at all. So *wrong* judgements always result from an interplay between pure intellect and pure senses. The crucial point is that both intellect and senses are never pure. All knowledge and every judegment is dependent on both. Kant calls this relation a »function« (in the mathematical sense) with the intellect on the x-axis and the senses on the y-axis. So every knowledge is located somewhere on the curve of that function, and Kant coins the term »illusion« for this relation. The interesting point is, that it's impossible to get rid of that kind of illusion. That's why Kant calls it *transcendental illusion*. One might uncover that transcendental illusion by transcendental critique, but it's impossible to gain any knowledge without illusion. And more than this: the illusion is not only ›natural‹ (Kant) and unavoidable for every knowledge

[*Erkenntnis*] but it's the fundament of reason [*Vernunft*] itself. Illusion is essential for the reason to work.

So the *first* remark I'd like to make is that the discussions about analog and digital, about information and logical calculus are discussions about *illusion* in a Kantian sense with the analog, the form, and the material synapse in the role of the *senses*, and the digital, the medium, and the logical synapse in the role of the *intellect*. Both Wiener's claim for a ›balance of power‹ between them and Stroud's ›devil in between‹ are ways of respecting the illusionary function. Von Neumann's, Shannon's, or McCulloch's ambitions of forgetting or neglecting the analog, the medium, and the materiality as irrelevant (and thus building up a hierarchy) are attempts to get rid of the illusion and to gain error-free judgements. But as Kant already has proved two centuries before, it's an illusion to get rid of the illusion. I would suspect that even some of the high ambitions during the first wave of cybernetics were doomed to fail because of that disrespect to the illusionary function.

My *second* remark refers to a broader historical use of the term »illusion«. It was Michel Foucault who picked it up from Kant in his (still unpublished) PhD thesis in 1961 [Foucault, 1961, pp. 124ff]. According to Foucault's diagnosis ›Man‹ has become an illusionary construction in the 18th century. Man is (as Foucault says) an ›empirical/transcendental doublet‹, something that is both the empirical object of knowledge *and* the center of every possible knowledge, something that needs to be understood *and* makes understanding possible at all. So ›Man‹ is a sort of new capture for Kant's diagram. Man is an illusion that is indispensable for the human sciences to work. Foucault perceives this as a shift from one illusion to another: the *metaphysical* illusion was resolved by Kant's critical project, but in the same turn an *anthropological* illusion was installed by the so-called ›human sciences‹. A few years later Foucault called this illusion the »anthropological sleep« of philosophy and claimed for ways of waking it up. And it sounds as if his suggestions were

inspired by cybernetics: to question human sciences, to formalize instead of anthropologize, to demystify instead of mythologize, and to explore a way of thinking without thinking that it's Man that thinks.

So if cybernetics really established a new order of things in the middle of the 20th century and served as a kind of wake-up from the anthropocentric sleep, I would suggest that something happened that is quite similar to the epistemological break in the 18th century. If there once was a shift from *metaphysical illusion* to *anthropological illusion*, then there must be some kind of *cybernetic illusion*. Due to my inability to describe this new kind of illusion exactly, I would like to end up with three open questions and speculations.

First: With reference to McCulloch's Platonism I tried to underline the notion of information as something that is neither matter nor energy. Nevertheless information is something that has an abstract and a material side, a logical and a physical existence, something that is timeless but is also working in the ›instrumets of time‹ like brain tissue, weapons, digital computers etc. Taken this into account, there might be good reasons to call it an ›empirical/transcendental doublet‹ too. (Remember Foucault's definition that Man is both the empirical object of knowledge *and* the center of every possible knowledge. The same might be said about information.) That implies that if the new ›experimental epistemology‹ is based on »information«, it is based on something that is a no less ambigous figure than »Man« was before.

Second: If (according to McCulloch) »all understanding of our world« (Pias, 2003, vol. 1, p. 719) is based on information and feedback, then the situation is (in a certain way) as paradox as it was before, when the notion of Man was required for »all understanding«. If there existed several narrations (like life, economy, or language) that only made sense with reference to an abstract category of Man, then (under cybernetic conditions) these stories have to be rewritten with reference to information and feedback. But the paradox is, that the relation between Cybernetics (written with a capital C) is as unfair or

unjust in relation to every single, material, historical cybernetic arrangement as the relation between Man (written with a capital M) was unfair in relation to every single, living, mortal human being. If the attempt to think a non-contradictive unity of Man produced illusions, then why should the attempt to think a non-contradictive unity of technology be without illusions?

Third: According to Foucault it was part of the anthropological illusion to oversee that Man was constructed by technologies of power and knowledge, and that it was a phantasmagoric form of self-naturalization that shaded or hided these technologies. So the question might be, if there was a similar kind of theoretical shift in the history of cybernetics. A shift from experiments to instruments, from hypothetical constructions and pataphysical machines (just remember the discussions on laughing computers at *Macy's*) to instrumental hardware and institutionalized computer science, from speculations to explanations, from questions about the in-betweens to certainties of answers. I just like to mention two personal observations here: One is that the enormous wave of cybernetic publications suddenly stopped around the mid-70's, and I am still wondering what has happened. The other is that (at least in Germany) a university-discipline called »informatics« [*Informatik*] was founded in 1968 – but not as an institutionalized form of cybernetics but in opposition to it. Informatics was the creation of practitioners from engineering, economy, and applied mathematics who didn't dream the cybernetic dream of epistemological unity, but provided industry, economy and administration with academically trained experts in systems engineering and systems analysis.

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I suspect that Heinz von Foerster was invited to join the Macy-Conferences because Warren McCulloch had the idea that his presence would strengthen the arguments of the ›digital fraction‹ of cyberneticians attempting to build effective machines, to get rid of ›illusions‹ and thus becoming metaphysicists

in their very own way. Foerster's work on memory (Foerster, 1948; Pias, 2003, vol. 1, pp. 98-121) seemed to support this new digital discourse perfectly, and it was announced by McCulloch as an example for »other ways of thinking than those which are common to psychologists« (Pias, 2003, vol. 1, p. 97) – thus helping to get rid of (for example) Heinrich Klüver's confusing and notorious questions and interjections on neurosis. But although Foerster's lecture deals with a defined amount of discrete »carriers« over a time-function, he never mentions the terms ›analog‹ and ›digital‹. Even in his later summary on conferences VI-VIII he just carefully states: »The applicability of digital notions to the actions of the central nervous system has been questioned, but the calculus worked out for handling them is [...] applicable to electronic digital computers« (Pias, 2003, vol. 1, p. 346) This application was left to John von Neumann, whose logical (or ›ignorant‹) abstraction of digital computers (Neumann, 1945) remained triumphal against most alternative ways of computing (like Multi-valued Logic, Harvard Memory Architecture, Very Long Instruction Word, Massive Parallel Processing or Quantum Computing) during the last 50 years. But cybernetics is not a mono-causal success-story of faster and faster Von-Neumann-machines, but a world full of »epistemic objects« (Bruno Latour). It's not accidental that magician Heinz von Foerster's work is a critique of such illusions to get rid of the illusion. For me, von Foerster's work (and especially that of? the *Biological Computer Laboratory*) represents the so far most important consideration upon the three questions raised concerning the ›cybernetic illusion‹ and it's foundation in repressing the analog. First, it was a plea against ignorance and trivialization and for respecting of the material culture not only that? of cybernetics. Second, it was a plea against the totalitarian view that ›all understanding of our world‹ is based on computable numbers and solvable problems. Third, it was a plea for keeping cybernetics experimental instead of instrumental, and to raise questions instead of providing solutions.

Notes

[1] Found in the Warren McCulloch-Papers at the *American Philosophical Society,* Philadelphia, B/M 139.
[2] The german word »Geist« has far more metaphysical connotations than the english »mind«.

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